

CLAIMS

I/We claim:

- [c1] 1. An aircraft system, comprising:
an airfoil portion configured to be positioned external to an aircraft fuselage;
a connecting portion configured to rotatably connect the airfoil portion to the fuselage; and
a roller arrangement positioned to be coupled between the connecting portion and the fuselage, the roller arrangement including:
a roller support coupleable to one of the fuselage and the connecting portion;
an arcuate track coupleable to the other of the fuselage and the connecting portion, the arcuate track having a contact surface;
and
at least one roller rotatably carried by the roller support and having an external surface, the external surface of the roller being in load bearing contact only with the contact surface of the arcuate track.
- [c2] 2. The system of claim 1 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion.
- [c3] 3. The system of claim 1 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion, the web portion being generally normal to the flange portion, further wherein the roller includes a first roller rotatable about a first axis, and wherein the roller arrangement further includes a second roller having an external surface in contact with the web portion, the second roller being rotatable about a second axis generally normal to the first axis, the first and second rollers restricting motion of

the canard relative to the arcuate track in directions generally normal to the first and second axes while allowing the connecting portion to rotate relative to the arcuate track.

[c4] 4. The system of claim 1 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion, the web portion being generally normal to the flange portion and having a first surface and a second surface facing opposite from the first surface, and wherein the roller support includes a first portion and a second portion removably coupled to the first portion, further wherein the roller includes a first roller positioned between the first and second portions of the roller support and rotatable about a first axis, and wherein the roller arrangement further includes:

a second roller having an external surface in contact with the first surface of the web portion, the second roller being rotatable about a second axis generally normal to the first axis, the second roller being carried by the first portion of the roller support;

a third roller having an external surface in contact with the second surface of the web portion, the third roller being rotatable about a third axis generally normal to the first axis and generally parallel to the second axis, the third roller being carried by the second portion of the roller support, the second portion of the roller support being removable from the first portion of the roller support to allow access the third roller.

[c5] 5. The system of claim 1 wherein the arcuate track has an arcuate extent of less than 360 degrees.

[c6] 6. The system of claim 1 wherein the arcuate track has an arcuate extent of 360 degrees.

[c7] 7. The system of claim 1 wherein the connecting portion is rotatable relative to the arcuate track about a rotation axis, and wherein the contact surface of the arcuate track faces outwardly away from the rotation axis.

[c8] 8. The system of claim 1 wherein the connecting portion is rotatable relative to the arcuate track about a rotation axis, and wherein the contact surface of the arcuate track faces inwardly toward the rotation axis.

[c9] 9. The system of claim 1 wherein the roller includes a first roller and the arcuate track includes a first arcuate track, and wherein the system further comprises:

- a second arcuate track generally coaxial with the first arcuate track, the second arcuate track having a contact surface; and

- a second roller having an external surface, the external surface of the second roller being in contact only with the contact surface of the second arcuate track.

[c10] 10. The system of claim 1 wherein the roller includes a first roller and the arcuate track includes a first arcuate track, and wherein the system further comprises:

- a second arcuate track generally coaxial with the first arcuate track, the second arcuate track having a contact surface;

- a second roller having an external surface, the external surface of the second roller being in contact only with the contact surface of the second arcuate track;

- a shaft carrying the first and second rollers; and

- a spherical bearing carried by the shaft.

[c11] 11. The system of claim 1, further comprising:
the fuselage;
a wing depending from the fuselage; and

a propulsion system depending from at least one of the fuselage and the wing.

[c12] 12. The system of claim 1 wherein the at least one roller includes a first roller, and wherein the roller arrangement further includes a second roller spaced apart from the first roller around the arcuate track, the second roller having an external surface in load bearing contact only with the contact surface of the arcuate track.

[c13] 13. A canard assembly for an aircraft, comprising:
an airfoil portion configured to be positioned external to an aircraft fuselage;
a connecting portion configured to rotatably connect the airfoil portion to the fuselage; and
a roller arrangement positioned to be coupled between the connecting portion and the fuselage, the roller arrangement including:
a roller support coupleable to one of the fuselage and the connecting portion;
an arcuate track coupleable to the other of the fuselage and the connecting portion, the arcuate track having an arcuate contact surface and a web portion disposed inwardly from the contact surface;
a plurality of radial rollers rotatably carried by the roller support, each of the radial rollers having an external surface in load bearing contact only with the contact surface of the arcuate track; and
a plurality of thrust rollers rotatably carried by the roller support, each of the thrust rollers having an external surface in load bearing contact only with the web portion of the arcuate track.

[c14] 14. The assembly of claim 13 wherein each of the radial rollers is rotatable about a first axis and each of the thrust rollers is rotatable about a second axis, the first axes being at least generally orthogonal to the second axes.

[c15] 15. The assembly of claim 13 wherein each of the radial rollers is rotatable about a first axis and each of the thrust rollers is rotatable about a second axis, the first axes being at least generally orthogonal to the second axes, and wherein the connecting portion is rotatable about a third axis generally parallel to the first axis, and wherein the roller support includes a bracket having a first pin carrying at least one of the radial rollers in contact with the contact surface, and a second pin carrying at least one of the thrust rollers in contact with the web portion of the arcuate track, and wherein a load applied to the at least one radial roller in a direction generally parallel to the second axis increases a force applied by the at least one thrust roller to the web portion.

[c16] 16. The assembly of claim 13 wherein the web portion includes a first surface facing a first direction and a second surface facing a second direction opposite the first direction, and wherein at least one of the thrust rollers engages the first surface and at least one of the thrust rollers engages the second surface.

[c17] 17. The assembly of claim 13 wherein the roller support includes a bracket having a first pin carrying at least one of the radial rollers and a second pin carrying at least one of the thrust rollers, and wherein the first pin and the at least one radial roller is removable from the bracket without disengaging the at least one thrust roller from contact with the web portion.

[c18] 18. The assembly of claim 13 wherein the web portion includes a first surface facing a first direction and a second surface facing a second direction opposite the first direction, and wherein the roller support includes a bracket having a first bracket portion and a second bracket portion, the first bracket portion carrying at least a first one of the thrust rollers in contact with the first surface of the web portion, the second bracket portion carrying at least a second one of the thrust rollers in contact with the second surface of the web portion, the first bracket portion being removable from the roller arrangement independently of the second bracket portion.

[c19]

19. An apparatus, comprising:
- a first structure;
 - a second structure positioned at least proximate to the first structure, the second structure being rotatable relative to the first structure about a rotation axis; and
 - a roller arrangement coupled between the first and second structures, the roller arrangement including:
 - a roller support coupled to one of the first and second structures, the roller support having a first portion and a second portion;
 - an arcuate track coupled to the other of the first and second structures;
 - a first roller rotatably carried by the first portion of the roller support and having a generally smooth, uniform first external surface, the first external surface of the first roller being in load bearing contact only with the contact surface of the arcuate track, the first roller being positioned to roll along the contact surface;
 - a second roller rotatably carried by the second portion of the roller support and having a generally smooth, uniform second external surface, the second external surface of the second roller being in load bearing contact only with the contact surface of the arcuate track, the second roller being positioned to roll along the contact surface, the first and second rollers together restricting motion of the second structure relative to the first structure in opposing directions along a normal to the rotation axis.

[c20]

20. The apparatus of claim 19, further comprising a third roller carried by the roller support and having a third external surface in load bearing contact only with the contact surface of the arcuate track.

[c21] 21. The apparatus of claim 19 wherein the first portion of the roller support includes a first bracket and wherein the second portion of the roller support includes a second bracket.

[c22] 22. The apparatus of claim 19 wherein the first portion of the roller support includes a first bracket and wherein the second portion of the roller support includes a second bracket, the first bracket being removable from the roller arrangement independent of the second bracket.

[c23] 23. The apparatus of claim 19 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion.

[c24] 24. The apparatus of claim 19 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion, the web portion being generally normal to the flange portion, and wherein the first roller is rotatable about a first axis and the second roller is rotatable about a second axis generally parallel to the first axis, and wherein the roller arrangement further includes a third roller having an external surface in contact with the web portion, the third roller being rotatable about a third axis generally normal to the first and second axes, the first, second and third rollers restricting motion of the second structure relative to the arcuate track in directions generally normal to the first and second axes while allowing the second structure to rotate relative to the arcuate track.

[c25] 25. The apparatus of claim 19 wherein the arcuate track includes a flange portion having the contact surface, and a web portion disposed inwardly from the flange portion, the web portion being generally normal to the flange portion and having a first surface and a second surface facing opposite from the first surface, and wherein the first portion of the roller support includes a bracket having a first bracket portion and a second bracket portion removably coupled to

the first bracket portion, further wherein the first roller is positioned between the first and second bracket portions of the roller support and is rotatable about a first axis, and wherein the roller arrangement further includes:

a third roller having an external surface in contact with the first surface of the web portion, the third roller being rotatable about a second axis generally normal to the first axis, the third roller being carried by the first bracket portion of the roller support; and

a fourth roller having an external surface in contact with the second surface of the web portion, the fourth roller being rotatable about a third axis generally normal to the first axis and generally parallel to the second axis, the fourth roller being carried by the second bracket portion of the roller support, the second bracket portion of the roller support being removable from the first bracket portion of the roller support to allow access the fourth roller.

[c26] 26. The apparatus of claim 19 wherein the arcuate track has an arcuate extent of less than 360 degrees.

[c27] 27. The apparatus of claim 19 wherein the arcuate track has an arcuate extent of 360 degrees.

[c28] 28. The apparatus of claim 19 wherein the contact surface of the arcuate track faces outwardly away from the rotation axis.

[c29] 29. The apparatus of claim 19 wherein the contact surface of the arcuate track faces inwardly toward the rotation axis.

[c30] 30. The apparatus of claim 19 wherein the arcuate track includes a first arcuate track, and wherein the system further comprises:

a second arcuate track generally coaxial with the first arcuate track, the second arcuate track having a contact surface; and

third and fourth rollers each having an external surface in load bearing contact only with the contact surface of the second arcuate track.

[c31] 31. A method for servicing a roller arrangement positioned between a first structure and a second structure to allow the second structure to rotate relative to the first structure about a rotation axis, the method comprising:

accessing the roller arrangement, the roller arrangement including an arcuate track coupled to one of the first and second structures, and a roller support coupled to the other of the first and second structures, the arcuate track having a web portion carrying a flange portion, the flange portion having a contact surface, the roller support carrying a first roller with an external surface in load bearing contact only with the contact surface, and a second roller with an external surface in load bearing contact only with the web portion;

removing one of the first and second rollers from the roller arrangement without removing the other of the first and second rollers; and
replacing the one of the first and second rollers with a replacement roller.

[c32] 32. The method of claim 31 wherein the first roller is carried by a pin and wherein removing one of the rollers includes removing the first roller and the pin.

[c33] 33. A method for servicing a roller arrangement positioned between a first structure and a second structure to allow the second structure to rotate relative to the first structure about a rotation axis, the method comprising:

accessing the roller arrangement, the roller arrangement including an arcuate track coupled to one of the first and second structures, and a roller support coupled to the other of the first and second structures, the arcuate track having a web portion carrying a flange portion, the web portion having a first surface and a second surface facing opposite from the first surface, the flange portion having a contact surface, the roller support carrying a first roller with an external

surface in load bearing contact only with the contact surface, a second roller with an external surface in load bearing contact only with first surface of the web portion, and a third roller with an external surface in load bearing contact only with second surface of the web portion;

removing one of the second and third rollers from the roller arrangement without removing the other of the second and third rollers; and replacing the one roller with a replacement roller.

[c34] 34. The method of claim 33 wherein the roller support includes a first bracket portion carrying the second roller and a second bracket portion carrying the third roller and wherein removing the one roller includes removing the second roller and the first bracket portion.